REMARKS:

1) In accordance with the PCT procedures, the original specification of this application was a direct literal translation of the corresponding PCT International Application text. The specification has now been amended in an editorial and formal manner, to better comply with typical US application style and format (for example including section headings and avoiding express reference to claims by number). These merely editorial amendments do not introduce any new matter. Entry thereof is respectfully requested.

2) Further according to the PCT procedures, the original claims of this application were a direct literal translation of the claims of the corresponding PCT International Application. The original claims have now been canceled, and new claims 16 to 21 have been introduced. New claims 16 to 19 substantially correspond to the claims of the counterpart European patent application. New claims 20 and 21 have been drafted "from the ground up" as a fresh approach at covering inventive subject matter in a somewhat different claim style and with different claim terminology, in comparison to the original literally translated claims. New independent method claims 16 and 20 are supported by the subject matter of original claims 1, 2, 3, 12, 13 and 14, the specification at page 6 line 16 to page 7 line 24, and Fig. 2. New independent apparatus claims 18 and 21 are supported by the subject matter of original claims 8, 9, 11, 13 and 14, the specification at page 8 line 12 to page 9 line 21, and Fig. 3.

New claim 17 is supported by original claim 15. New claim 19 is supported by original claim 11. Thus, the new claims do not introduce any new matter. Entry and consideration thereof are respectfully requested.

3) Referring to section 4 on pages 2 to 3 of the Office Action, the objection to the drawings is respectfully traversed.

The cited claims 2, 3, 13, 14 and 15 have been canceled, so that this particular objection has been obviated. Nonetheless, it is acknowledged that the cited features of the invention are still included in the new claims, so that a similar objection could be asserted against the new claims. The objection is respectfully traversed for the following reasons.

It is generally only required that the new or inventive features of an invention are shown in the drawings, to the extent that such features can be illustrated. 37 CFR 1.81(a), (b) and (c). Conventional features that are well understood by persons of ordinary skill, without requiring an illustration for the understanding thereof, do not need to be explicitly shown in the drawings. Also, features that cannot be illustrated do not need to be shown.

Among the features pointed out by the Examiner, the "six workpiece coordinates" and the "five machine coordinates" are well understood by persons of ordinary skill in the art, without requiring an illustration thereof (see the discussion below regarding the well understood conventional meaning of six workpiece coordinates and five machine coordinates). The "interpolation parameters" are also conventionally understood

parameters (for example relating to the interpolation of points of the spine along the path length or the milling time over which the spline is defined; see page 8 lines 4 to 11 of the specification). Also, such parameters cannot be coherently or sensibly illustrated in a way that would enhance the understanding thereof. Also see the discussion below regarding the conventionally understood interpolation parameters.

Moreover, simply providing an illustration of a rectangular box labeled "six workpiece coordinates" or "five machine coordinates" or "interpolation parameters" would not serve to further enhance the understanding of the invention. See 37 CFR 1.83(a).

As will be further discussed below, the "six splines" and the "five splines" involve respectively one spline allocated to each respective one of the six workpiece coordinates or the five machine coordinates. It is simply not possible to illustrate such a multi-dimensional feature in a sensible and coherent fashion on a two-dimensional drawing sheet. Particularly, the problem at hand involves five or six dimensions or coordinates, and correspondingly five or six splines respectively allocated to the five or six coordinates, and it is not deemed possible to illustrate all five or six splines together for all five or six coordinates as a function of path distance or milling time in a two-dimensional illustration. Instead, a representative spline for one single coordinate has been illustrated as an example in Fig. 2. It can be understood that the other splines allocated to the other coordinates could be illustrated similarly in a schematic fashion like Fig. 2, but providing such additional

illustrations of the individual splines allocated to the individual coordinates would not provide a further improved understanding.

For the above reasons, the objection to the drawings and the requirement for additional or supplemented drawings are respectfully traversed. Please withdraw the objection to the drawings.

4) Referring to section 6 on pages 3 to 5 of the Office Action, the objection to claims 12 to 14 has been obviated by the cancellation of those claims. The new claims have proper dependency, i.e. avoid the objection raised by the Examiner. Accordingly, please withdraw the objection.

5) Referring to section 8 on pages 5 to 7 of the Office Action, the rejection of claims 2, 3 and 13 to 15 under 35 USC 112(1) for lack of enablement, is respectfully traversed.

Claims 2, 3 and 13 to 15 have been canceled. To the extent that the features allegedly lacking enablement are included in the new claims, this rejection is respectfully traversed, for the following reasons.

A person of ordinary skill in the art readily understands that six coordinates are specified for each machining control point in a workpiece coordinate system. The six workpiece coordinates define the location of the milling tool in three spatial directions or axes (e.g. in Cartesian coordinates X, Y, Z), as well as the orientation of the milling tool in three coordinates in the form of a tool direction vector, thus giving

a total of six coordinates. Similarly, a person of ordinary skill in the art readily understands that five coordinates are specified for each machining control point in a machine coordinate system. Particularly, the five machine coordinates include three coordinates defining the location of the milling tool in the three spatial directions or axes, as well as two coordinates defining the orientation of the milling tool with two spatial angles (rotary coordinates), thus giving a total of five coordinates.

In this regard, for example, see the EP 1,235,126 (Hirai et al.) reference cited by the Examiner, at paragraph [0045], defining a workpiece coordinate system with six coordinates (X, Y, Z, I, J, K), and a machine coordinate system with five coordinates (Mx, My, Mz, B, C). These well-known principles are also sufficiently described in the present application (see pages 5 lines 1 to 12, page 7 lines 7 to 24, etc.).

Thus, contrary to the Examiner's assertions, a person of ordinary skill in the art would readily understand how a milling or machining control point can be (and must be) defined by more than three coordinates. It is not only the location of the "single point in space", but also the orientation of the milling tool at that point in space, which must be defined.

Regarding prior claim 13, the Examiner pointed out that "*one of ordinary skill in the art would not know how a tool path could comprise five or six splines*". The Examiner is essentially correct that a person of ordinary skill in the art, based only on the prior art teachings, would not have known how a tool path could be defined by five or six splines as according to the

present invention. This is a key feature of the invention, however, and is adequately disclosed and enabled in the present application (see page 7 line 15 to page 8 line 11). Particularly, according to the present invention, one respective independent spline is generated respectively for each one of the workpiece coordinates or the machine coordinates so that there is a total of six splines respectively allocated to the six workpiece coordinates or a total of five splines respectively allocated to the five machine coordinates. Thus, each spline is a mathematical representation of only the single given coordinate to which this spline is allocated, as a function of the milling time or the milling path length (page 7 line 7 to page 8 line 11).

For example, in the workpiece coordinate system, a first spline would be defined for the successive X-coordinates of all of the successive machining control points, a second spline would be defined for the successive Y-coordinates of all of the successive machining control points, a third spline would be defined for the successive Z-coordinates of all of the successive machining control points, and three more splines would similarly respectively be defined for the three coordinates of the directional vector of the orientation of the milling tool at the successive machining control points. So, each machining control point is defined by six coordinates in the workpiece coordinate system, while a first spline is defined for all of the first coordinates, a second spline is defined for all of the second coordinates, a third spline is defined for all of the third coordinates, a fourth spline is defined for all of the fourth

coordinates, a fifth spline is defined for all of the fifth coordinates, and a sixth spline is defined for all of the sixth coordinates of the successive machining control points.

Such an allocation of six splines to six workpiece coordinates for a succession of machining control points, whereby each spline is a function of the respective associated coordinate over time or milling path distance, cannot be sensibly illustrated in a two-dimensional drawing. Nonetheless, this construct of six splines can be understood by referring to the single spline shown in Fig. 2, and further understanding that there are five more similar splines for the five other coordinates of a workpiece coordinate system, whereby all five of the splines are synchronized with one another over the path length or the milling time (see page 8 lines 8 to 11).

This can also be understood in a practical application as follows. A five-axis milling machine has five degrees of freedom for independent motion on each of the five machine coordinate axes. The milling machine will have five independent control arrangements, e.g. five control motors, respectively individually allocated to the five controllable axes. According to the invention, the five splines respectively allocated to the five machine coordinates can be individually allocated to control the respective associated five control motors of the milling machine. Namely for example, the X-coordinate spline will control the X-axis drive motor, the Y-coordinate spline will control the Y-axis drive motor, the Z-coordinate spline will control the Z-axis drive motor, etc. As the five drive motors are respectively controlled by the five splines in synchronism with

one another, the milling tool is moved relative to the workpiece in a coordinated manner under the control of all five splines respectively for the five axes of freedom of motion of the milling machine.

Regarding claim 15, it is respectfully submitted that the "interpolation parameters" are sufficiently disclosed in the specification (page 8 lines 4 to 11). Upon reading that disclosure, a person of ordinary skill in the art would have readily understood that the five or six splines would simply have to be defined as respective functions of the given coordinates over the milling time or over the milling path length, so that all of the splines would thereby be synchronized, and all of the splines together define a single tool path as six functions over time or path length. The intermediate values of the functions are thus interpolated or determined between the given milling control or support points over the milling path length or the milling time. Any conventionally known interpolation scheme can be used to generate the intermediate interpolated values of the functions, as long as it is used consistently for all of the splines, over the milling path length or the milling time.

For the above reasons, the Examiner is respectfully requested to withdraw the rejection under 35 USC 112(1) for lack of enablement.

6) Regarding section 10 on page 7 of the Office Action, the rejection of claims 1 to 3, 8, 9 and 11 to 15 under 35 USC 112(2) as being indefinite is respectfully traversed. The original claims have been canceled. The new claims avoid unclear phrases

such as "especially". The "interpolation parameters" are positively introduced in new claim 17 and have been discussed above in connection with the preceding rejection. Accordingly, please withdraw the indefiniteness rejection under 35 USC 112(2).

7) Referring to section 12 on pages 8 to 12 of the Office Action, the rejection of claims 1 to 3, 8, 9 and 11 to 14 as anticipated by EP 1,235,126 (Hirai et al.) is respectfully traversed.

The original claims have been canceled. New claims 16 to 21 have been introduced, including independent method claims 16 and 20, and independent apparatus claims 18 and 21.

Each of the new independent claims defines special features of the invention that distinguish the claims over the prior art, as follows. A first important feature of each independent claim is that a respective independent spline is respectively generated for each one of the workpiece coordinates or machine coordinates, so that there is a total of six splines respectively allocated to the six workpiece coordinates or a total of five splines respectively allocated to the five machine coordinates. A second important feature of the invention defined in each independent claim is that the plural splines are generated directly from the support points or way points. Namely, the splines are generated dependent on and fitting the respective coordinates of the support points or way points, as discussed above, so that a first spline is defined to fit the first coordinate of all the way points, a second spline is defined to fit the second coordinate of all the way points, a third spline is defined to fit the third coordinate of all the way points, etc. This is a very

straightforward, efficient, and effective manner of generating splines to define the five or six coordinates of a tool path for carrying out the milling of the desired freeform surface. This programming can easily be carried out in a CAD/CAM apparatus, by programming in the support points or way points of the required tool path (see the specification at page 5 lines 13 to 19 and page 7 lines 15 to 24).

In contrast of the present invention, the Hirai et al. reference discloses a method by which a machining tool is controlled along a tool path by approximating the intended tool path with a succession of basis splines (NURBS: Non-Uniform Rational B-Splines). The tool path is thus generated as a succession of basis splines that are sufficiently smoothly joined to each other, and represent a successive concatenation of ellipses, circles, hyperboles, etc. The control is carried out by converting the basis splines into polynomials. Thus, the tool path is then provided in a form of transformed three-dimensional polynomials in space. In this regard, Hirai et al. also disclose a process for converting data from a workpiece coordinate system to data in a machine coordinate system (see paragraphs 0017, 0022, 0023, 0024, 0046, 0060, 0065, 0076, 0083, etc.).

Hirai et al. do not disclose generating five or six independent splines respectively allocated to the five or six coordinates, directly from the coordinate data of the way points or support points, as according to the present invention.

For the above reasons, the Examiner is respectfully requested to withdraw the anticipation rejection applying Hirai

et al., because this rejection is not applicable against any of the new claims 16 to 21.

8) Favorable reconsideration and allowance of the application, including all present claims 16 to 21, are respectfully requested.

Respectfully submitted,
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Enclosures:
Transmittal Cover Sheet
Term Extension Request
Form PTO-2038

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